

**SemiAnnual Status Report**

NASA Grant NsG-446

June 1965

**Effects of Schedule and Stimulus Parameters**  
**on Monitoring and Observing Behavior.**

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1315 West Tenth Street  
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**Period covered by Report:** 1 December 1964 through 31 May 1965.

FACILITY FORM 602

N65-87880

(ACCESSION NUMBER)

14  
(PAGES)

CR-64571  
(NASA CR OR TMX OR AD NUMBER)

(THRU)

None  
(CODE)

(CATEGORY)

## 2. PROGRESS DURING THE PERIOD OF THIS REPORT.

(a) Equipment development. Two time data sorters were designed and constructed for recording distributions of observing interresponse times and of detection times. Each sorter has eighteen class intervals, accepts data from relay pulse-formers and is programmed through solid state circuits from an external source of timing pulses.

(b) Observing and detection behavior as a function of signal frequency. The observing schedule established during the previous semi-annual period was continued with four squirrel monkeys. Under this procedure, depression of a lever switch produces either a brief exposure of a green pushbutton key light or exposure of a red key light. All responses on the red pushbutton produce semi-liquid food reinforcement. The red key light remains present until a key response occurs and is reinforced. Key responses in the dark or green have no consequence. Red key availabilities are programmed according to random interval schedules, and the key remains dark when no lever responses occur. Under this procedure, lever responses function as observing responses which result in exposure of discriminative stimuli on the key. Red key lights function as "signals" and key responses are "detections."

During the period of this report this procedure was continued. Daily sessions were extended to two hours and the mean intersignal availability time was increased from 40 sec. to 1 min. This resulted in no decrease in the observing rate. Under the 1 min. random interval schedule of signal availability, the green (no signal or  $S^{\Delta}$ ) exposure time was manipulated to determine its effects on the observing rate. The green exposure was shortened from 1 sec. to 0.5 sec., and then to 0.25 sec. The observing rate increased as a function of decreasing  $S^{\Delta}$  exposure time, although the effect was smaller between 0.5 sec. and 0.25 sec. A 0.50 sec. green exposure was selected as

being of sufficient duration for easy discriminability without placing a ceiling on the observing rate. Two contingencies which were utilized in establishing the observing baseline were now eliminated. One of these had precluded reinforcement of a response to the dark key, and one had prevented reinforcement of key responses immediately following "incorrect" responses to the dark or green key lights. Both contingencies had been employed to accelerate the initial reduction in key responses in the dark and green key conditions (analogous to "false" detections). With the removal of these contingencies the observing response functioned only to expose discriminative stimuli on the key, without affecting the probability of reinforcement of key responses. In other words, a 1 min. random interval was programmed on the key regardless of the occurrence of observing responses which produced stimuli correlated with the availability or non-availability of reinforcement. This change resulted in no increase in key responses in the dark or green, which remained at a very low level, nor did it produce a decrease in the rate of observing responses. Response rates on the key stabilized at essentially the rate of reinforcement in one subject and at 10-20 percent above the rate of reinforcement in the other three subjects.

The 1 min. random interval schedule of reinforcement was maintained until observing rates and key rates had stabilized. The left frames of Figures 1 through 4 give the frequency distribution of observing inter-response times (IRT's) for each of the four subjects following stabilization of the 1 min. schedule. Data are for a single 2-hour session. The first (cross-hatched) 0.5 sec. class interval is the green key ( $S^A$ ) exposure time, which constitutes the first part of each observing IRT. During the green exposure an additional response has no consequence, i.e., it neither produces an additional green exposure nor prolongs the exposure time of the current stimulus.

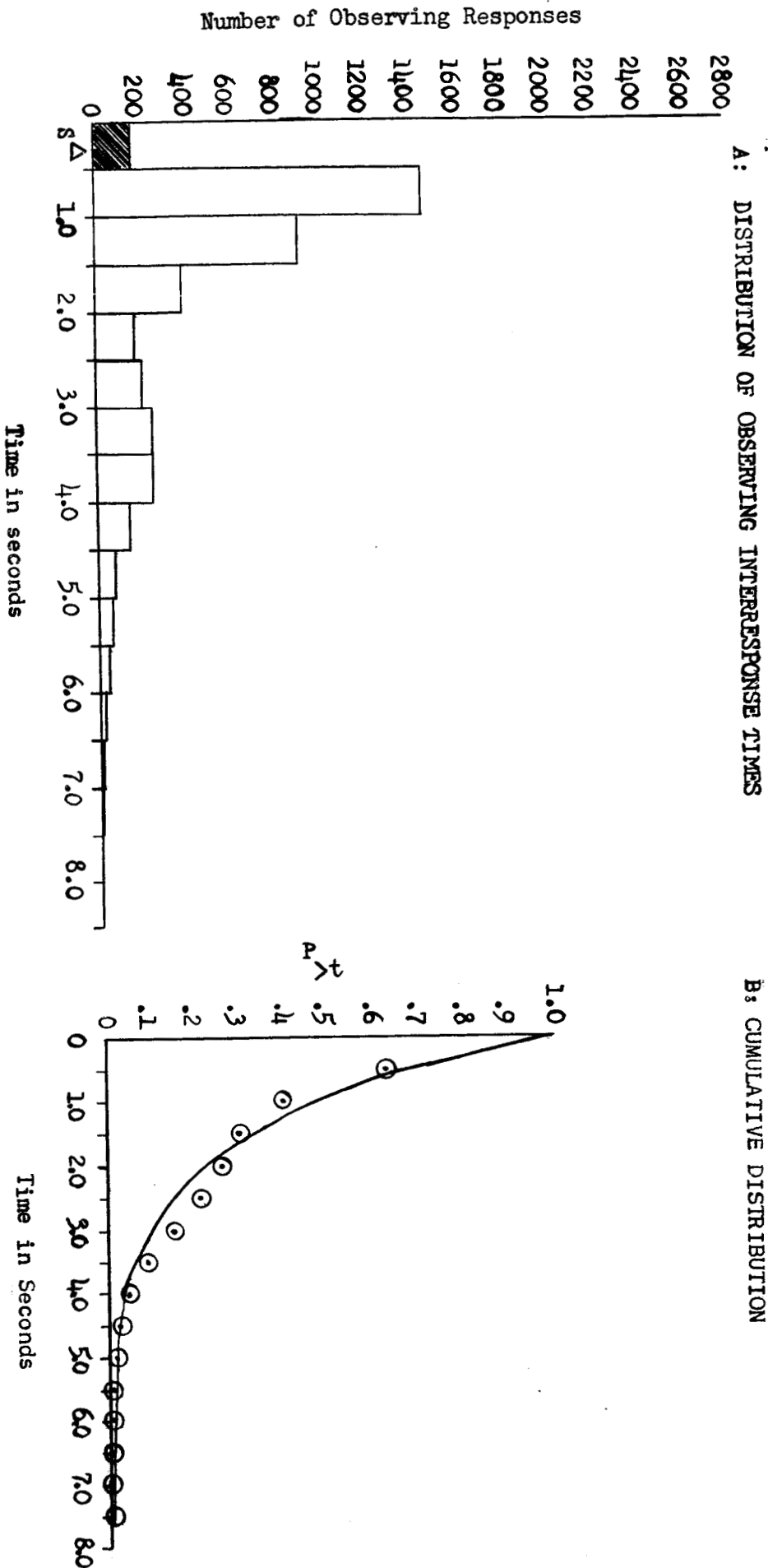
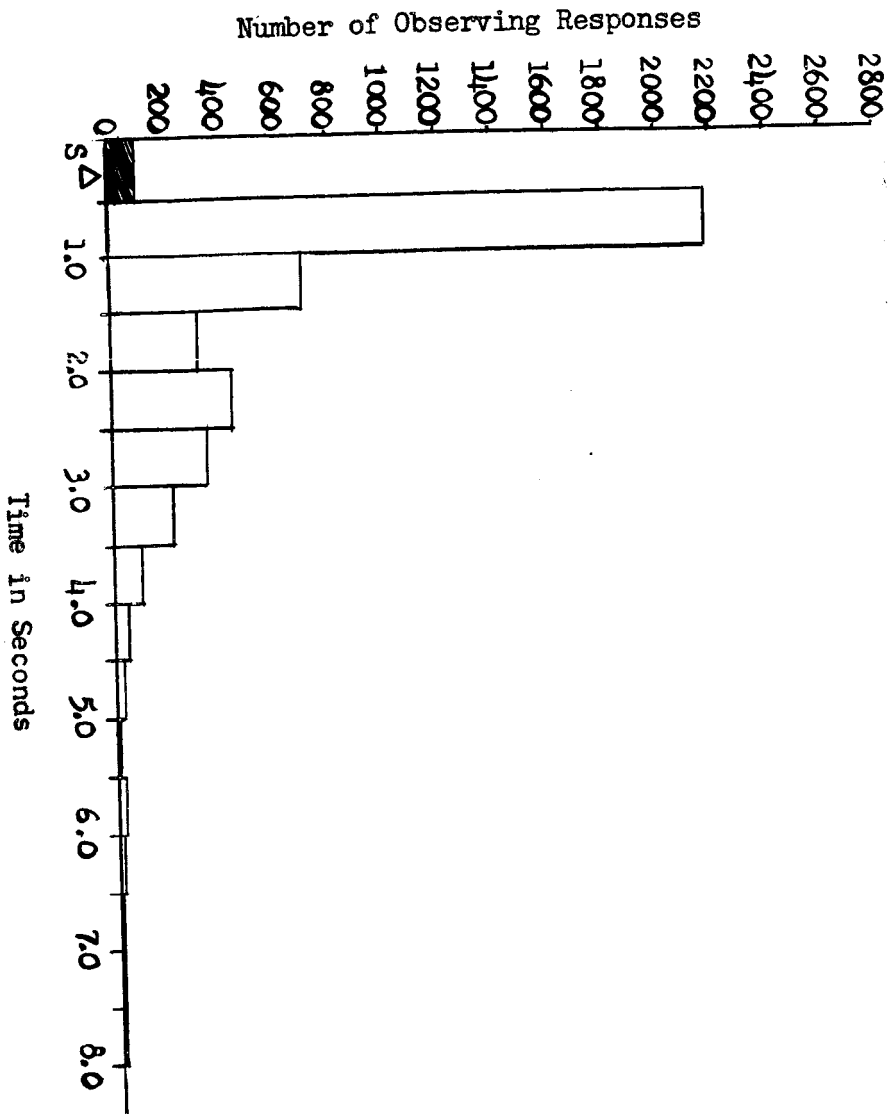


Fig. 1 Distribution of observing interresponse times for 1 subject (M-2). The cumulative distribution is plotted with  $S\Delta$  time and responses removed from the distribution. The smooth curve represents the equation  $P_t = e^{-rt}$  where  $P_t$  = the proportion of interresponse times greater than  $t$  and  $r$  = the mean observing rate during dark key time.

A: DISTRIBUTION OF OBSERVING INTERRESPONSE TIMES



B: CUMULATIVE DISTRIBUTION

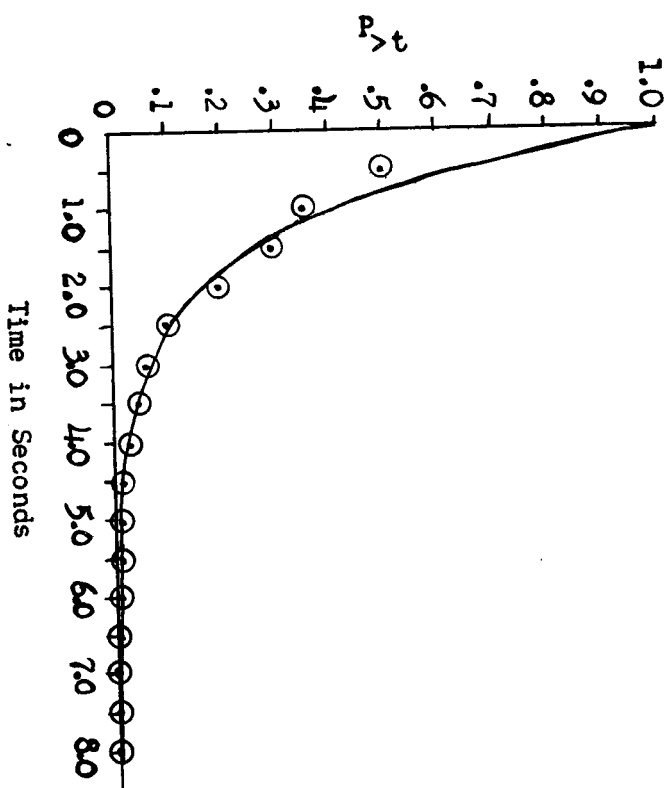


Fig. 2 Distribution of observing interresponse times for 1 subject (M-3). The cumulative distribution is plotted with SΔ time and responses removed from the distribution. The smooth curve represents the equation  $P_y t = e^{-rt}$  where  $P_y t$  = the proportion of interresponse times greater than  $t$  and  $r$  = the mean observing rate during dark key time.

SUBJECT M-3  
 SCHEDULE 1' VI  
 MEAN OBSERVING  
 RATE = 54.6 R's/min.



SUBJECT M-8  
 SCHEDULE 1' VI  
 MEAN OBSERVING  
 RATE = 22.2 R's/min.

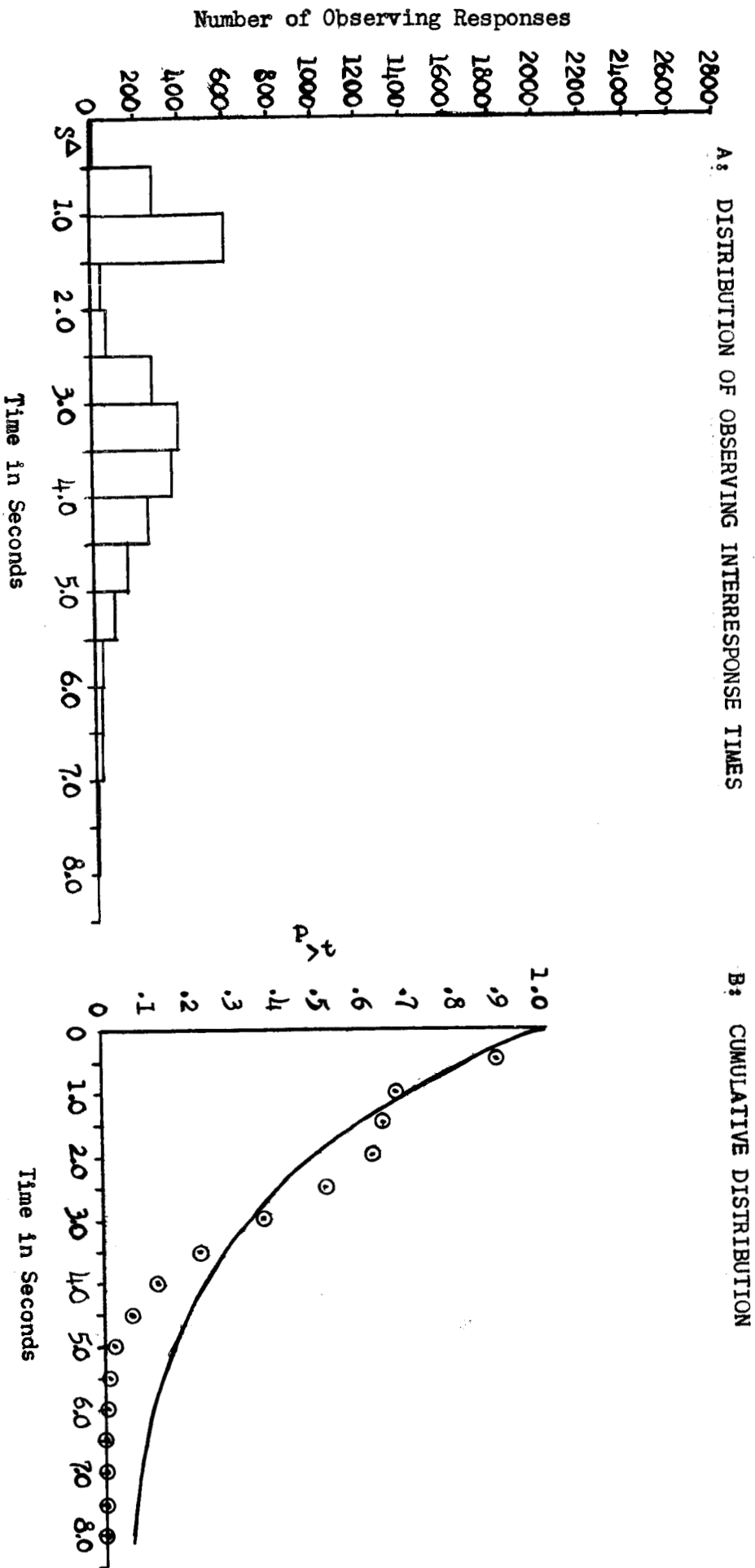


Fig. 4 Distribution of observing interresponse times for 1 subject (M-8). The cumulative distribution is plotted with  $S\Delta$  time and responses removed from the distribution. The smooth curve represents the equation  $P_t = e^{-rt}$  where  $P_t$  = the proportion of interresponse times greater than  $t$  and  $r$  = the mean observing rate during dark key time.

The small numbers of observing responses in the first ( $S^A$ ) class interval are apparently largely due to occasional occurrences of topographies which might be described as "double-responses." The right frames of Figures 1 through 4 give the cumulative distribution of observing IRT's corresponding to the histograms at the left, but with both the time and responses in  $S^A$  removed from the distribution. Empirically, it has been found that observing responses occur randomly in three of the four subjects if one considers only the dark key time (i.e., time during which the observing response has a stimulus-producing consequence). The smooth curves in the right frames of Figures 1 through 4 give the expected cumulative Poisson distributions under these conditions (Mueller, 1950; Feller, 1957). The mean rate is the only parameter of these distributions. In Figures 1 through 4 the mean rate has been determined from the total number of observing responses in the dark key condition divided by the total dark key time, and not directly from the distribution of observing IRT's. Only in the case of the fourth subject (M-8) is there much evidence of non-randomness in the temporal distribution of observing responses in the absence of signals. This subject's observing IRT distribution (left frame, Fig. 4) shows bimodal characteristics often associated with DRL schedules of reinforcement. This might possibly be related to the use, during preliminary training, of the Page discrimination procedure, which has DRL characteristics. It remains to be seen whether observing IRT's will continue to be generally random at lower signal frequencies.

Figures 5A and 5B give the distribution of detection times on the stabilized 1 min. random interval schedule for each subject. The detection time is defined as the time from onset of a red key light to the occurrence of the key response (which terminates the red light and initiates a maga-

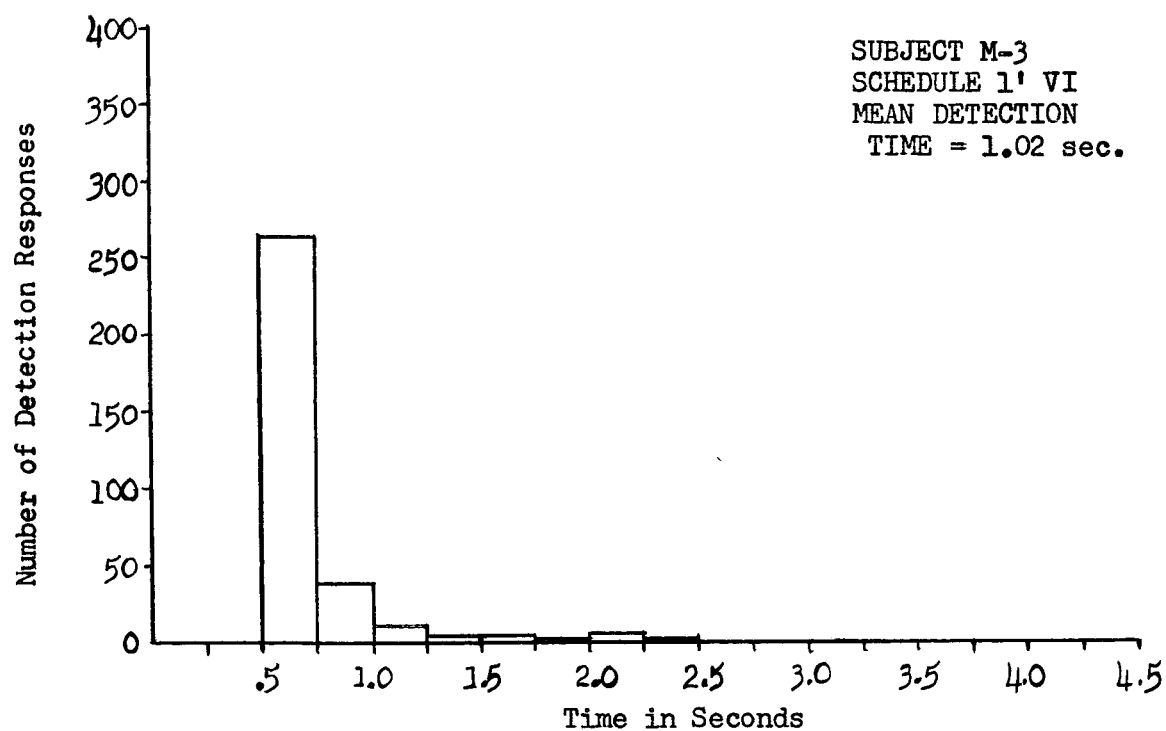
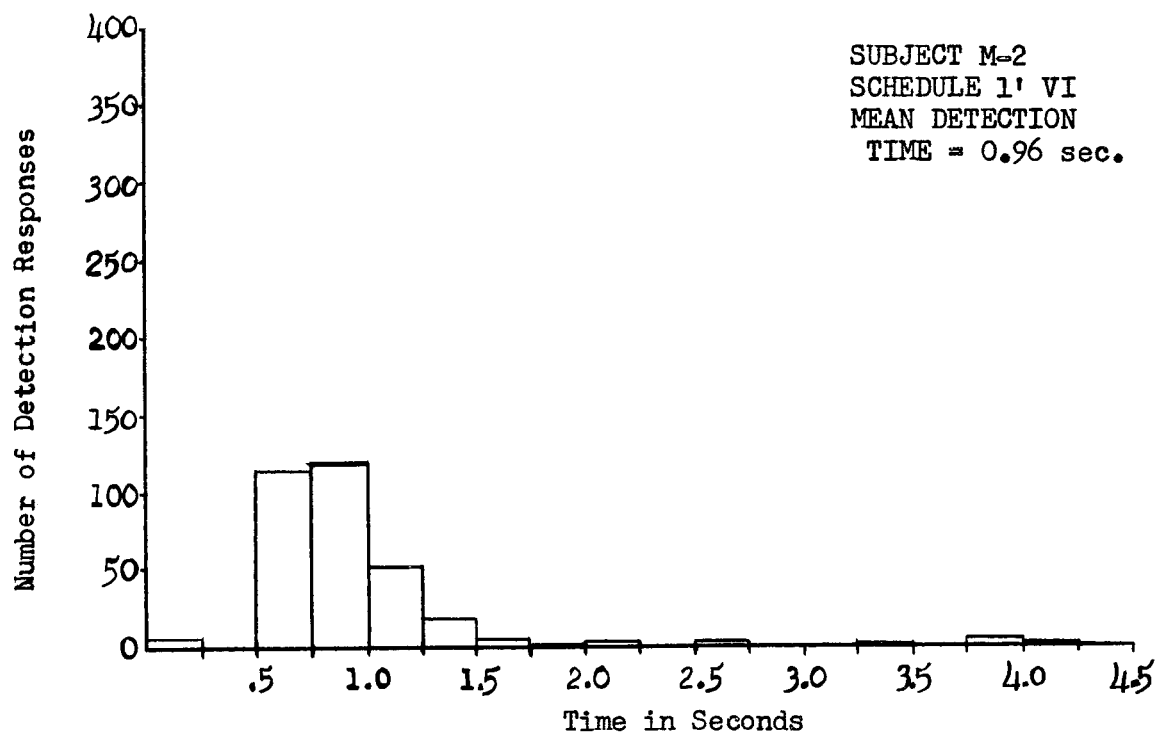


Fig. 5A Distribution of detection times for the first two subjects.  
Data are pooled from three two-hour sessions on 1' VI.

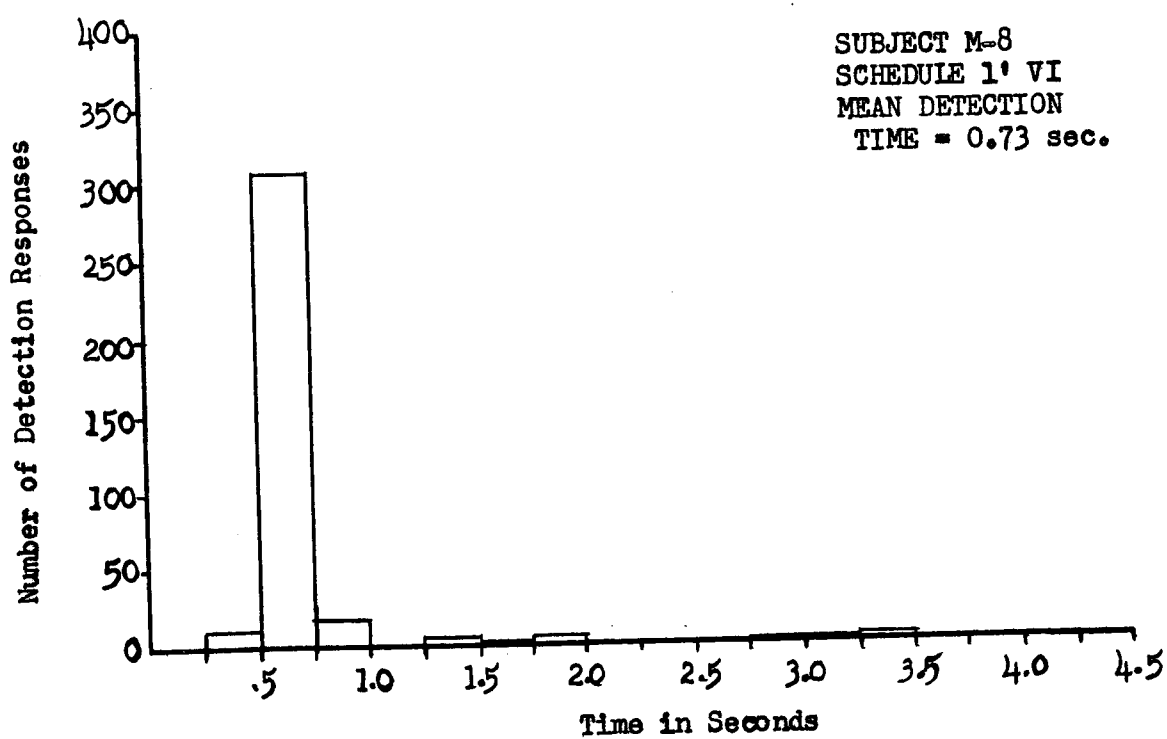
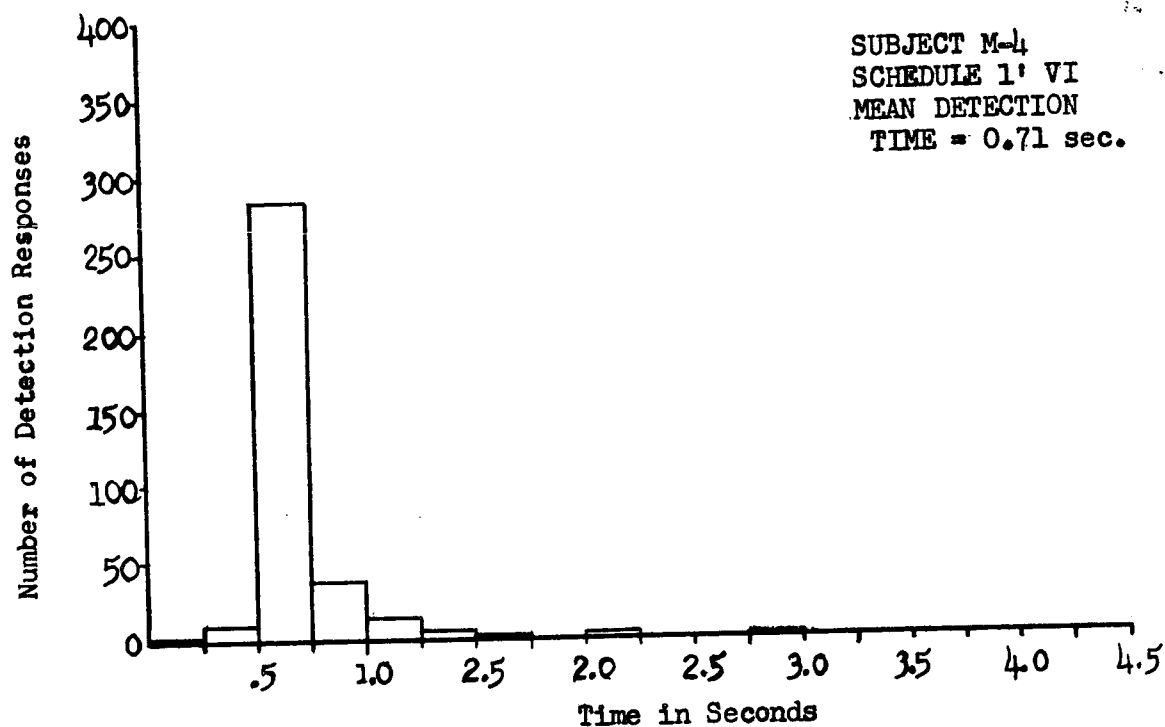


Fig. 5B Distribution of detection times for the second two subjects.  
Data are pooled from three two-hour sessions on 1' VI.

zine cycle). The data presented are based on three two-hour sessions. These distributions have been examined from several points of view and found not to conform to a random distribution. Hence, comparisons with a random distribution are not presented. In all cases the detection response appears to have a minimum latency of about 0.5 sec., and varies very little above this value except in the case of Subject M-2. The atypical data from M-2 may be related to this subject's topography which consists frequently of "jiggling" the key rather than striking it sharply.

So far as the present data are concerned inter-subject differences in observing rate appear to be unrelated to the detection time in the presence of the red key. Also, observing IRT distributions appear more nearly random where the observing rate is highest. This may be related to the properties of intercurrent behavior. For example, Subject M-2, which gave the second lowest observing rate and second poorest fit to a random distribution, has been observed to display grooming pauses which tend to increase as the session continues. It remains to be established whether a systematic relationship between the observing rate and detection time obtains in the face of changes in signal frequency.

This experiment is being continued to obtain observing and detection data under lower signal frequencies. A 2 min. random interval schedule of signal availability is presently being stabilized, and 4 min. and 8 min. schedules are tentatively to be examined.

(c) Effects of amphetamine upon observing behavior. Because of the general interest in the effects of certain drugs upon hypothetical states of the organism such as "vigilance" and "drive," the effects of d-amphetamine sulfate upon observing behavior under the 1 min. random interval schedule were examined. After preliminary experimentation on this, doses of 0.125, 0.25,

and 0.50 mg./kg., i.m. were administered 15 min. prior to daily sessions with appropriate saline controls. In general the effect of d-amphetamine is to lower the observing rate progressively as a function of increasing dose. This takes the form of increasingly long pauses during which no responses occur on the observing lever. During such pauses subjects were observed to be hyperactive, and when responding on the observing lever was resumed it occurred at normal rates. The subjects also appeared to "ignore" the key and key stimuli and in several cases responded to neither manipulandum for periods of 1 hour or more in the face of a red key light. In one case the subject also emitted occasional responses on the lever in the presence of a red key. In general, the effect of the drug appears to consist of a complete disruption of the task rather than differential interference with different components of the normal chain of responses. This effect appears somewhere between 0.125 and 0.25 mg./kg. and its duration increases with the dose. The 0.50 mg./kg. dose eliminated nearly all responding in all subjects for the duration of the two hour session.

It is anticipated that the effects of amphetamine on monitoring behavior will be re-examined under lower signal frequencies. From the data already obtained it can be concluded that all effects of the drug under high signal frequencies are deleterious from the point of view of efficiency in the detection of signals.

(d) Publications. The following technical articles which were prepared earlier appeared during the period of this report:

Clark, F. C. Emulsification of liquid monkey food. J. exp. anal. Behav., 1965, 8, 16.

Clark, F. C., & Hull, L. D. The generation of random interval schedules. J. exp. anal. Behav., 1965, 8, 131-133.

Reprints of these articles have been forwarded.

3. ANTICIPATED WORK DURING THE NEXT SEMI-ANNUAL PERIOD. (1 June 1965- 31 December 1965)

Dr. John O. deLorge, an experimental psychologist, will begin work on the project during this period. Experiments on the effects of signal frequency as an independent variable will be continued, and one or two additional experiments will be begun in order to examine the effects of other independent variables upon observing and detection behavior.

4. REFERENCES.

Feller, W. An introduction to probability theory and its applications.

2nd. edition. New York: John Wiley & Sons, 1957.

Mueller, C. G. Theoretical relationships among some measures of conditioning. Proced. Nat. Acad. Sci., 1950, 36, 123-130.